PRODUCER GAS FOR ENGINES.[1]

II.—TESTS AND EFFICIENCIES.

MR. DUGALD CLERK had careful tests made with a 30-B.H.P. plant and a 40-B.H.P. plant of the type shown in Fig. 2 of the article published last week, and found that the heat efficiency of the former gas was 83 per cent. and that of the latter as high as 90 per cent., both with hot starts.[2] In Table A, I give the results obtained with the last-named suction plant, and for comparison the results with a steam-jet pressure plant of the same power, and the average of results with seven other pressure plants of different sizes :—

TABLE A.

Comparison of Suction and Pressure Plants.

	Suction plant 40 B.H.P. (hot start)	Pressure plant 40 B.H.P. (hot start)	Pressure plants. Average of 7 plants (hot start)
Fuel used	Anthracite	Anthracite	Anthracite
Composition of gas (per cent. by volume)—			
Hydrogen	15·64	19·8	17·36
Methane	1·16	1·3	1·20
Carbon monoxide	20·13	23·8	25·55
Carbon dioxide	6·09	6·3	5·77
Oxygen	0·74	—	0·30
Nitrogen	56·24	48·8	49·82
Total combustible gases (per cent. by volume)	36·93	44 9	44·11
Calorific power (higher scale)—			
Calories per cubic metre	1204	1463	1432
B.Th.U. per cubic foot	135·3	164·4	161·0
Air required for combustion of unit volume	0·927	1·162	1·122
Yield of gas—			
Cubic metres per kilo. of fuel ...	5·80	5·04	5·01
Cubic feet per ton of fuel	208,000	181,000	180,000
Approximate power given by an engine which will give 100 H.P. with gas of Column 3	93	100	100

The practical outcome of many tests made with engines worked with suction plants is that with a full load, or nearly full load, the consumption when running is a little under 1 lb. of anthracite, or about $1\frac{1}{8}$ lb. of gas-coke per B.H.P.-hour. This is exclusive of the fuel burnt when starting and during the stand-by hours. The consumption of fuel and water in the small plants (about 20 B.H.P.), tested at Derby in 1906 on behalf of the Royal Agricultural Society was as follows :—

Anthracite	Full load ...	1·1 lb. per B.H.B.-hour, including fuel for starting and banking during the night.
	Half load ...	1·6 lb. per B.H.P.-hour, including fuel for starting and banking during the night.
	Water ...	1 gallon per B.H.P.-hour at full load.
		$\frac{3}{4}$,, ,, half ,,
Coke	Full load ...	1·3 lb. per B.H.P.-hour, including fuel for starting.
	Water ...	1·5 gallons per B.H.P.-hour at full load.

I had an interesting test made with a 250-B.H.P. engine and suction plant, working night and day for 123 hours without a stop. The engine worked a dynamo, and readings were taken every half-hour of the current generated. The general result was that the consumption of small anthracite, including all sources of waste, was only 1·23 lb. per kilowatt-hour. On the assumption that the efficiency of the dynamo was 90 per cent., this corresponds with 0·82 lb. per B.H.P.-hour.

Close attention is usually given to the consumption of fuel per H.P.-hour, sometimes to the thousandth of a pound, and it is not a little remarkable that a separate account is seldom taken of the consumption of fuel while the steam or gas plant is standing with a fire in it. The stand-by loss of a boiler is much greater than that of a gas producer, and the explanation is not far to seek; for a given H.P. the producer is much smaller, and has far less radiating surface than a boiler; it has no water in it to be heated, and it can be worked up to its maximum production in about fifteen minutes, after standing almost any length of time. With a boiler, except in the vertical or portable type, there is a large amount of external brickwork to be heated, and there is a considerable quantity of water, even in the tubular type. When the boiler is standing the water and the brickwork lose heat, and not only more time, but more fuel, is required to make up this loss than in the case of a gas producer. Doubtless the heat efficiency of a good boiler is high when it is working to nearly its full capacity, but the reverse is the case when it is standing. Table B gives some comparative results :—

TABLE B.

Consumption of Fuel in Stand-by Hours.

Steam power			Gas power	
Type of boiler	Max. H.P. of boiler	Coal consumed per standing hour	Max. H.P. of producer	Coal consumed per standing hour
		lbs.		lbs.
Various	100	14·0	250	5·1
Lancashire	450	37·5 [1]	250	3·9
Babcock and Wilcox.	210	67·0	100	2·1
,, ,,	210	67·0	250	4·5
,, ,,	500	180·0	225	3·8
,, ,,	500	112·0	375	1·8
Niclaussé	400	50·0		
Lancashire	400	44·7		
	Average ...	71·5	Average ...	3·5

On this basis, if a 200-B.H.P. steam plant works eight hours and is standing sixteen hours, and if it consumes 2·5 lb. per B.H.P.-hour, the stand-by loss will be more than 20 per cent. of the total fuel consumed in twenty-four hours. Under like conditions, if a gas plant of the same power consumes 1 lb. per B.H.P.-hour, the stand-by loss will be under 4 per cent. With a 500-B.H.P. plant the stand-by loss with steam will be about 15 per cent., and with gas under 2 per cent. If we take the percentage of the stand-by loss on the fuel consumed during the working hours, we have the following results :—

	200 B.H.P.		500 B.H.P.
Steam power	26·8 per cent.	...	17·9 per cent.
Gas power	3·8 ,,		2·0 ,,

The accompanying Figs. 3, 4, 5, and 6 show at a glance the relative heat efficiencies of a steam boiler and steam engine, and of a gas plant and gas engine of the same power; Figs. 3 and 4 are each for 250 B.H.P., and Figs. 5 and 6 are for 40 B.H.P. The blank space at the top of each column represents the number of heat units (100 calories or B.Th.U.) in the fuel consumed to produce the same amount of useful work. For the 250-B.H.P. steam plant I have taken 80 per cent. as the heat efficiency of the boiler, and for the 40 B.H.P. 75 per cent.; for the condensation in pipes, driving feed-pumps and other usual losses, I have taken 10 per cent. of the total heat for the larger plant and 5 per cent. for the smaller one. For the larger steam engine I have assumed a heat efficiency of 15 per cent., and for the smaller one 10 per cent. For the 250-B.H.P. gas power I have assumed that the gas plant is of the steam-jet pressure type, and that, including its small boiler, the heat efficiency is 80 per cent. For the 40-B.H.P. gas power I have assumed that the gas plant is of the suction type, and that its heat efficiency is 85 per cent. With gas plants there are no losses from condensation or other causes beyond those allowed for in the above percentages. For the gas engines I have assumed a heat efficiency of 28 per cent., and in all the diagrams I have taken the friction of the engine as 15 per cent. The figures given for the fuel consumed correspond approximately with the following consumptions of fuel of average quality :—

900 grams	(2 lb.)	per B.H.P.-hour	for	250	B.H.P.	steam power
450 ,,	(1 lb.)	,,	,,	,,	,,	gas power (pressure plant)
1350 ,,	(3 lb.)	,,	,,	40	,,	steam power
400 ,,	(0·9 lb.)	,,	,,	,,	,,	gas power (suction plant).

In Fig. 3, 1120 heat units are absorbed in the boiler, and of these 224 are taken as lost in ashes, radiation, flue

[1] Continued from p. 203.

[2] For full details of these trials see "Producer Gas," 2nd edition (Longmans).

[1] Exclusive of raising the steam pressure from 90 lb. to 120 lb.

gases, &c.; the steam generated represents 896 units, and of these 112 are lost by condensation, &c. The steam supplied to the engine represents 784 units, and of these 667 are lost in the exhaust, so that only 117 are converted into indicated work, and from this 17 are deducted for friction. In Fig. 4 525 heat units are absorbed in the producer, and of these 105 are taken as lost in ashes, radiation, cooling of gas, &c. The gas supplied to the engine represents 420 units, and, as in Fig. 3, 117 units are converted into indicated work, and of these 17 are deducted for friction. In Fig. 5 1680 heat units are absorbed in the boiler, and of these 420 are lost in ashes, radiation, &c.; the steam generated represents 1260 units, and of these 84 are lost by condensation, &c. The steam supplied to the engine represents 1176 units, and of these no less than 1059 are lost in the exhaust. In Fig. 6 494 heat units are absorbed in the producer, and of these 74 are taken as lost in ashes, radiation, cooling of gas, &c. The gas supplied to the engine represents 420 units, and the remaining losses are similar to those in Fig. 4.

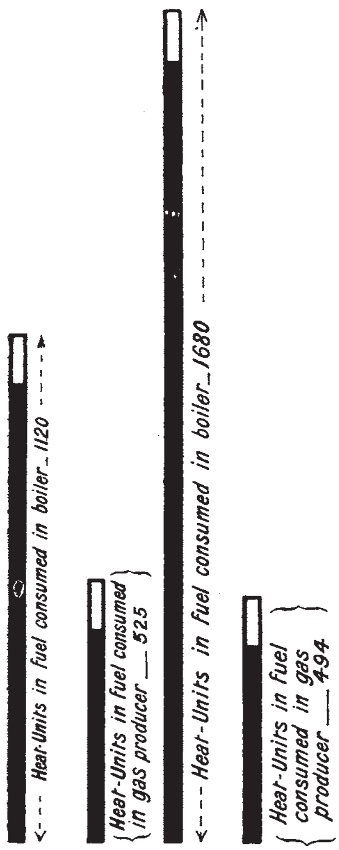


Fig.3. Fig.4. Fig.5. Fig.6.

Fig. 3.—250 B.H.P. steam.
Fig. 4.—250 B.H.P. gas.
Fig. 5.—40 B.H.P. steam.
Fig. 6.—40 B.H.P. gas.

On these bases the general result is that for the 250-B.H.P. size, in order to obtain 100 heat units in useful work with steam power there must be 1120 heat units in the fuel consumed in the boiler; whereas with gas power there need only be 525 units in the fuel consumed. This shows a saving of 53 per cent. in the weight of fuel in favour of the gas plant. The result is still more striking in the case of the 40-B.H.P. size, as there must be 1680 units in the fuel consumed for steam power compared with 494 for gas power. This is a saving of 70 per cent. in favour of the gas plant. These figures do not include any allowance for stand-by losses, which would be considerably less for gas than for steam power.

After considering the two types of plant, I think our general conclusions may be as follows:—A suction plant has certain practical advantages—it costs less and occupies a smaller ground-space; but the gas made in it is not so strong as in the older form of pressure plant, and in the case of large engines this advantage may be important, as it affects the maximum power of the engine. The fuel consumption per H.P.-hour and the labour required are about the same in both types of plant, provided the steam required is raised without an independent boiler. The consumption of water is the same in both types. Where there are several engines to serve, a pressure plant is better, as all can be served with one main from the gasholder, with a branch to each engine. This simplifies the piping and reduces its cost considerably; it also facilitates the starting of the engines. It seems to me that each plant has its own province, and that in some cases the pressure type is better than the suction type; in others suction is better than pressure.

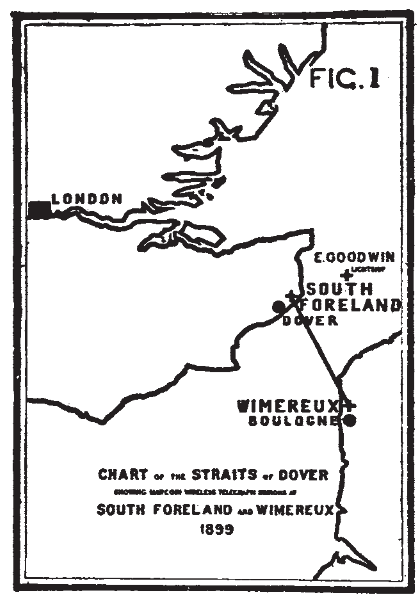
Looking at the matter broadly, one cannot but be struck with the enormous development in gas power which has taken place during the last ten, and especially during the last five, years. Small steam engines are being rapidly superseded, and in several cases the makers of steam engines are now making gas engines. At first only small gas engines were supposed to be within the range of practical politics, but those days are over, and there are many gas engines developing more than 1000 H.P. each which are working satisfactorily. Gas power has come to stay, and now has a recognised position among engineers.

J. Emerson Dowson.

TRANSATLANTIC WIRELESS TELEGRAPHY.[1]

On previous occasions I have had the honour of describing before this institution some of the stages through which the application of electric waves to telegraphy through space has passed. This evening I propose to confine myself chiefly to describing the results and observations recorded during the numerous tests and experiments which my collaborators and I have been carrying out with the object of proving that wireless telegraphy across the Atlantic was possible, not merely as an experimental feat, but as a new and practical means for commercial communication (Journ. Inst. Elec. Eng., xxviii., 1899, p. 291).

In March, 1899, communication was established by means of my system of wireless telegraphy across the Channel between England and France (see Fig. 1), and the *Times*



of March 29 of that year published the first Press telegram ever transmitted to England from abroad by means of electric-wave telegraphy.

At that time a considerable discussion took place in the Press as to whether or not wireless telegraphy would be practicable for much longer distances than those then covered, and a general opinion prevailed that the curvature of the earth would be an insurmountable obstacle to long-distance transmissions, in the same way as it was, and is, an obstacle to signalling over considerable distances by means of optical signals such as flashlights, the heliograph, or the semaphore.

Other difficulties were anticipated as to the possibility of being able practically to employ and control a transmitter capable of radiating an amount of electrical energy large enough to actuate a receiver at really great distances, and,

1 From a discourse delivered at the Royal Institution on Friday, March 13, 1908, by Commendatore G. Marconi.